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Detection of effective recombination centers in fluorescent SiC using thermally stimulated luminescence

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***Abstract*— Two n-type 6H fluorescent SiC (f-SiC) samples have been characterized using thermally stimulated luminescence (TSL) spectroscopy, where the dominant carriers recombination regime has been found via the numerical simulations.**

Keywords*— *6H SiC; TSL; re-trapping

I. INTRODUCTION

Fluorescent silicon carbide (f-SiC) is the emerging material for white light-emitting diodes (LED) thanks to its high conversion efficiency from near-ultraviolet (NUV) to visible light [1-2]. In order to get the deep understanding of how the donor-acceptor pair (DAP) recombination regime in f-SiC will affect its internal quantum efficiency (IQE), it is crucial to find out the specific site-dependent dominance of the DAP recombination in f-SiC. In this paper, two different n-type 6H f-SiC samples were characterized by thermally stimulated luminescence (TSL) spectroscopy, by further applying monomolecular and bimolecular thermal activation energy model developed by Halperin A. et al. [3] with our own modification according to the special case for the f-SiC material, we were able to find out the dominant carriers recombination regime and the dominant donor level in f-SiC.

II. RESULTS AND DISCUSSION

The results of the numerical simulation have fitted well with the corresponding main TSL peaks of each sample as shown in Fig. 1, where the calculated and the measured ratio (ELS569 to ELS118) of TSL peak values of these two samples were both ~2.31. The left shoulder of the fitted curve of ELS569 was a bit lower than that of the measured curve, this was caused by unfinished DAP luminescence [4]. In the inset of Fig. 1, the right shoulder of ELS569 is always higher than that of ELS118 (for ELS118, nearly close 0), and this phenomenon guided us to find out the second trap center in ELS569 which induced the second TSL peak with much lower TSL intensity and wide spread along the temperature. The effective donor level were calculated to be 43.4 meV and 42.3 meV for ELS118 and ELS569 respectively, where we can find that both ELS118 and ELS569 are dominated by two processes: the free-to-bound recombination and the DAP recombination with the donor levels related to the hexagonal site (~81 meV [5]). Furthermore, TSL processes for these two samples are both found to be re-trapping dominant, and there is even stronger re-trapping process in ELS569.

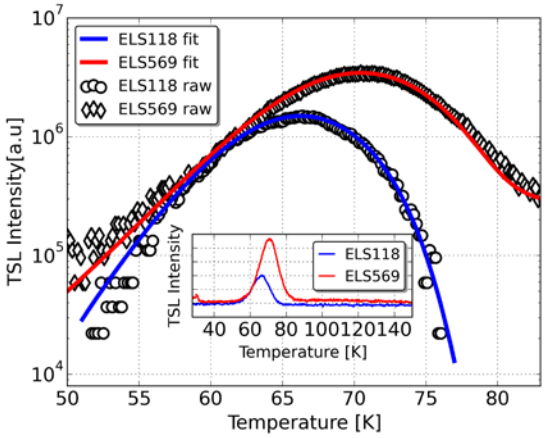

Fig. 1. The main plot: the measured and simulated main TSL curve of the two 6H f-SiC samples, the inset: the whole TSL curves with y-axis set as linear mode.

III. SUMMARY

In conclusion, we have investigated the dominant occupancies of the donor levels of two 6H f-SiC samples by applying the TSL method and the corresponding numerical simulation, and the radiative recombination is found to be dominated by both the free-to-bound and the DAP recombination related to hexagonal sites on donor levels. The strong re-trapping process was found on both samples.

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